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**REPORT OF GEOTECHNICAL  
EXPLORATION AND REVIEW  
VIRTUAL BUILDING  
TIMBERLAKE ROAD  
FAIRMONT, MINNESOTA**

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AET #08-05070

**Date:**

November 10, 2003

**Prepared for:**

City of Fairmont  
Attn: Mark Humboldt  
100 Downtown Plaza  
Fairmont, MN 56031



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City of Fairmont  
100 Downtown Plaza  
Fairmont, MN 56031

Attn: Mark Humboldt

RE: Geotechnical Exploration and Review  
Virtual Building  
Timber Lake Road  
Fairmont, Minnesota  
AET #08-05070

Dear Mr. Humbolt:

This report presents the results of a subsurface exploration program and geotechnical engineering review for the Propose Virtual Building in Fairmont, Minnesota. We are submitting three (3) copies of this report to you, two (2) additional copies are being sent as noted below.

The opinions expressed in this report are based upon the present conception of the proposed development and the data obtained from our subsurface exploration. Should there be any changes as the project develops, we request that we be notified so that these new conditions can be reviewed.

American Engineering Testing, Inc. appreciates this opportunity to serve you. As your project proceeds, we remain interested in providing additional consulting or testing services. If you have any questions about the report, or if we can provide additional services to you, I can be reached at (507) 387-2222.

Very truly yours,  
American Engineering Testing, Inc.

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Enclosures

cc: Keith Haff-Paulsen Architects

**GEOTECHNICAL EXPLORATION AND REVIEW  
FOR  
VIRTUAL BUILDING  
FAIRMONT, MINNESOTA  
AET #08-05070  
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**GEOTECHNICAL EXPLORATION AND REVIEW  
FOR  
VIRTUAL BUILDING  
TIMBER LAKE ROAD  
FAIRMONT, MINNESOTA  
AET #08-05070**

**SUMMARY**

**Purpose**

The purpose of our work on this project is to explore the subsurface conditions and provide geotechnical engineering recommendations to assist you and the project team in planning and constructing the project.

**Scope**

To accomplish the above purpose, you have authorized our firm to drill seven (7) test borings at the site, conduct laboratory testing, and prepare this geotechnical engineering report.

**Findings**

The test borings indicate a general soil profile of topsoil with glacial till at depth. No subsurface water was noted at the boring locations at the time that our fieldwork was performed; however, based upon our previous experience with clay till soils in the general project area, it is our opinion that the subsurface water levels at the site could be quite near the ground surface during periods of significant precipitation, particularly during the spring of the year. Variations in subsurface water levels should be expected seasonally, annually and from place to place.

**Recommendations**

These recommendations are condensed for your convenience. Study our entire report for detailed recommendations.

Based upon the results of the soil test borings, it is our opinion:

- The Proposed Virtual Building structure can be supported on conventional spread footings designed for an allowable soil contact pressure of 2000 psf after some soil correction.
  - The proposed on-grade floor slabs can be supported on the new engineered fill sequence developed from the suitable natural soils.
  - The soil correction should include removal of the existing topsoil deposits below the building areas. Where new fill will be placed below the bottom of the proposed footing elevations, the excavations should be oversized 1:1 below the edges of the footings and brought to design grade with compacted, engineered fill.
  - The floor slab can be supported on the engineered fill.
  - Additional excavation of some of the natural soils may be required if soft soil conditions are encountered.
  - Any new fill placed below the foundations and on-grade floor slabs should be compacted to a minimum of 95% of standard Proctor density (ASTM:D698).
- 
- The organic portions of surficial deposits should be removed in the proposed roadway areas prior to construction of the pavement section.
  - A corrective 2' deep subcut is recommended in the proposed paved areas prior to construction of the pavement section.
  - The pavement design should be based upon assuming a conservative "R" value of about 10.

## INTRODUCTION

This report presents the results of a subsurface exploration program and geotechnical engineering review for the Proposed Virtual Building in Fairmont, Minnesota.

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To protect you, AET, and the public, we authorize use of opinions and recommendations in this report only by you and your project team for this specific project. Contact us if other uses are intended. Even though this report is not intended to provide sufficient information to accurately determine quantities and locations of particular materials, we recommend that your potential contractors be advised of the report availability.

### Scope of Services

Our work on this project was authorized by Mr. Keith Haff of Paulsen Architects, on August 5, 2003. A review of our agreed-upon scope of services is as follows:

- Drill seven (7) standard penetration test borings and at the project site.
- Perform a nominal laboratory testing program to aid in predicting soil properties.
- Prepare an engineering report which includes logs of the test borings, presentation of the soil and ground water conditions, the laboratory test results and our geotechnical engineering opinions and recommendations regarding the following:
  - Grading procedures to prepare the building area for structural support;
  - Foundation types and depths, including allowable soil bearing capacity and estimates of foundation settlement;
  - Ground floor slab support, including recommendations on the need for a vapor or capillary water barrier;
  - Backfilling procedures, including material type and compaction requirements;
  - Subgrade preparation for bituminous pavements;
  - Estimated "R" values;
  - Pavement section thickness designs;
  - Recommendations regarding earthwork operations;
  - Comments on other items which may affect final performance or constructability, such as frost heave or drainage considerations;
  - Comments concerning the constructability of the recommended foundation type;
  - Quality control observations and testing.

The scope of our work is intended for geotechnical purposes only. This scope is not intended to explore for the presence or extent of environmental contamination at the site or to characterize the site relative to any other status such as wet land or historical significance.

### **PROJECT INFORMATION**

We understand that you are planning to construct a 28' eave height, precast concrete building at the project site. The proposed construction will consist of precast concrete wall panels, a precast concrete roof, interior steel columns, and cast in place concrete foundations. Further, we understand that the proposed structure will be supported on conventional spread-footing foundations founded at sufficient depth for protection from frost penetration. The proposed on-grade floor elevations will be at or slightly above existing site grade. The structure will have overall plan dimensions of 280' by 230' and will be located as shown on the attached site sketch.

We do not have specific structural loading information. Based upon previous experience with similar construction materials, we would estimate moderately light to moderate loadings for a structure of this type. We assume that wall loadings will be less than 8 kips per lineal foot and column loads will be less than 250 kips. Additionally, we estimate that floor slab loadings will be less than 200 pounds per square foot.

Paved areas will be bituminous mat/granular base sections designed to support automobile and light truck traffic; the finished pavement grade will be at or slightly above existing site grade.

The presented project information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

### **Foundation Design Assumptions**

Our spread foundation design assumptions include a minimum factor of safety of 3 with respect to a shear or base failure of the foundations. We assume the structure will be able to tolerate total settlements of up to 1", and differential settlements over a 30' distance of up to 1/2".

The presented project information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

## **SITE CONDITIONS**

### **Surface Observations**

The proposed project site is located just northeast of the intersection of Timber Lake Road and C.S.A.H. #26 in Fairmont, Minnesota. Nearby site features include commercial construction in all directions. Current site vegetation consists of crop residue.

The general site topography is level. Based upon the assumed benchmark datum, the surface elevations at the boring locations varied from 98.3' to 99.8'.

### **Subsurface Soils/Geology**

Logs of the test borings are included in the Appendix. The logs contain information concerning soil layering, soil classification, geologic description and moisture. Relative density or consistency is also noted, which is based on the standard penetration resistance (N-value).

The boring logs only indicate the subsurface conditions at the sampled locations and variations often occur between and beyond borings.

Based on our interpretation of the available boring information, it is our judgement that the generalized soil profile at the project site consists of topsoil with glacial till at depth.

The surficial topsoil layer was about 1 ½' to 2' deep at the boring locations. The topsoil consisted mostly of black, sandy lean clay with numerous visible organics.

The main geologic deposit encountered at the site consisted of clayey sand and sandy lean clay, glacial till. The upper portion of till was somewhat weathered. The till varied in color from brown mottled and brown nearer the surface to grey at depth. Additionally, the till contained some gravel and numerous lenses and layers of sand. The consistency of the till varied from medium to very stiff.

### Water Level Measurements

The boreholes were probed for the presence of ground water, and water level measurements were taken. The measurements are recorded on the boring logs. A discussion of the water level measurement methods is presented in the SUBSURFACE EXPLORATION section of this report.

The depth or lack of subsurface water noted at the boring locations should not be taken as an accurate representation of the actual subsurface water levels. A long period of time is generally required for groundwater to stabilize in the impermeable soils generally present at the site; this period of time is generally not available during a typical subsurface exploration program.

Based upon our previous experience with clay till soils in the general project area, it is our opinion that the subsurface water levels at the site could be quite near the ground surface during periods of significant precipitation, particularly during the spring of the year.

Ground water levels usually fluctuate. Fluctuations occur due to varying seasonal and yearly rainfall and snow melt, as well as other factors.

## GEOTECHNICAL CONSIDERATIONS

### Review of Soil Properties

The following geotechnical considerations are the basis for the recommendations presented later in this report.

- Strength - The existing topsoil deposits were judged to have very low strengths. The natural clay till was judged to have low to moderate strengths.
- Compressibility - The existing topsoil deposits are also judged to be compressible under anticipated footing loadings. Some of the upper clay till will be moderately compressible under anticipated loads. The clay till present at the boring locations at depth would generally be fairly incompressible under the anticipated loadings.
- Frost Susceptibility - It is our judgment that the near surface soils are at least moderately frost susceptible. If these soils remain in-place and are allowed to freeze, we anticipate heave may potentially be on the order of 1/4" to 3/8" for each foot of frost penetration within the soil, which could translate to 1" to 2" of total movement. This could be exaggerated further if free water were available such that ice lensing could be formed. Movements of exterior sidewalks/slabs is especially important in building doorway areas. These exterior features should be designed to accommodate such frost movements, or the on-site soils should be subcut and replaced with low frost susceptible sands; subsurface drainage should be provided.

In bituminous parking and drive areas, frost heaving is less of a problem unless the heave occurs as an abrupt differential movement. For this reason, consistency of soil conditions or gradual changes of conditions across the pavement area is desirable.

- Drainage Properties - The majority of the soils are considered to be poorly draining materials. Water can temporarily perch over the on-site soils during wet weather. This is an important consideration beneath exterior slab and pavement areas, particularly when overlain by new sand fill. Trapped water can lead to exaggerated abrupt frost heaving and softening of the subgrade. Where the potential for perched water exists, you should consider the placement of draitile lines or other means of drainage to relieve water buildup.
- Expansive/Shrinkage Potential - Although no Atterberg limits or expansion tests were performed, the soils encountered were judged to be "lean", which refers to soils having liquid limits less than 50%. Based on this, we judge that the on-site soils have a relatively low potential for expansion or shrinkage due to corresponding changes in moisture content.

### Discussion

Spread footing foundations are generally the most economical type of foundation system. It is our judgement that a spread footing foundation system should be feasible for this project after a program of soil improvement. We judge that the needed soil improvement should be less costly than an alternate foundation type such as a deep foundation.

The existing topsoil is not judged suitable for building or floor slab support. Excavation of this material from within the building area is necessary. Also, some of the soft, clayey soil may not be suitable and may also have to be partially replaced.

## RECOMMENDATIONS

### Site Preparation

#### Excavation

To prepare the proposed building areas for conventional spread footing/slab-on-grade construction, all of the existing topsoil deposits present should be removed from within the building area

Some additional excavation of the natural soils present at the site may be required depending upon the actual soil conditions encountered in the field at the time excavation is performed.

Where new fill will be required below foundations, the excavations should be oversized laterally at the bottom so that the resultant fill system can provide support for the lateral loads exerted. Based on the conditions encountered, we recommend that the excavation bottom include a 1:1 oversizing. That is, for each vertical foot of fill required below the foundation, the excavation should be oversized laterally beyond the foundation/footing that same distance. Any loose disturbed areas should be replaced with new fill.

The natural soils present at the boring locations at proposed bottom of excavation elevations will be extremely sensitive to disturbance during construction. Care will be required during earthwork operations to reduce the risk of soil disturbance. Excavation should be performed with a smooth bucket, backhoe to reduce soil disturbance. Also, excavation for and construction of the foundation elements should be performed in a timely manner to minimize disturbance of the soils present at the site.

The risk of soil disturbance increases significantly when water is present. The amount of water encountered by the excavation at the site will be dependent upon seasonal fluctuations, the excavation depths required and the amount of sands encountered. Because of the impermeable nature of the majority of the subsurface soils present at the boring locations, it likely would be possible to control water entering into the excavation with normal sump pumping procedures. However, given the possibility of lenses and layers of sand, more intricate dewatering techniques may be required depending upon the subsurface water levels present during construction and the excavation of depths required. Any water which does collect in the open excavation should be quickly removed and surface drainage away from the excavation should be provided during construction.

Any tile or utility lines present should be rerouted around the building area.

Because soil conditions can vary between boring locations, it is highly recommended that a geotechnical engineer/technician observe the final excavation prior to new fill or footing placement.

#### Filling

Fill required to attain grade for foundations and floor slabs should be uniformly compacted in thin lifts. We recommend the following density levels for various structural areas:

- Below Footings  
2000 psf - 95%
- Floor Slab Areas only - 95%
- Pavements and sidewalks (upper 3') - 100%
- Pavements and sidewalks (below 3') - 95%

All percentages expressed as minimums of standard Proctor density, ASTM:D698.

For ease of placement and compaction, we recommend using a granular material with a maximum size of 2" and less than 15% fines.

For a sand fill, we recommend a maximum lift thicknesses on the order of 1'. We recommend compacting with a moderately heavy, vibratory compactor.

Any fill placed in or near water should be a medium/coarse grained, free draining sand with less than 40% passing the #40 sieve and 5% passing the #200 sieve. Additionally, the initial lift of fill should be about 2' to lessen the risk of disturbing the natural soils present at the site.

Exterior backfilling of foundations, even in non-basement situations, can potentially result in distress if cohesive/silty soils are used for backfill. Such soils, when they become wetter, can adhere to masonry walls and actually lift the walls off the foundations as they freeze and heave. Solutions to this phenomenon, known as adfreezing, include installing a slip surface against the wall, such as a double layer of polyethylene, or using well drained sand backfill. Minimizing surface water infiltration to the area also reduces the potential. Also, any exterior walls, sand backfill should be capped with a 1' to 2' layer of compacted clay and sloped to provide positive surface drainage away from the structure.

### Foundations

After preparing the site as previously recommended, it is our judgment that the structure can be supported on a conventional spread footing foundation. We recommend that perimeter foundations for heated building spaces be placed such that the bottom is a minimum of 42" below final exterior grade. Interior foundations can be placed at a convenient depth below the floor slab. We recommend exterior foundations not bordering heated building space (such as canopy foundations) be extended to a minimum of 60" below exterior grade.

Based on the soil conditions encountered at the borings and on the minimum fill compaction level recommended, it is our opinion that the foundations can be designed based on a maximum allowable soil contact pressure of 2000 psf. It is our judgment that this design will include a factor of safety of about 3 or greater against shear or base failure.

It is our judgment that total building settlement could be about 1" and differential settlement could be on the order of 1/2". In-place soil conditions different from those depicted at the boring locations could increase the magnitude of expected settlement.

Spread footings should be proportioned such that a minimum 2' x 2' area is provided for pad footings and a minimum 2' width is provided for strip footings.

### **Floor Slabs (On-Grade)**

We recommend providing a 4" to 6" thick continuous sand cushion layer directly below the floor slab to prevent capillary moisture rise to the slab. This free-draining granular fill should contain less than 5% by weight passing the #200 sieve, and less than 40% passing the #40 sieve. This refers to sands which have the SP or SW designation, and which are mostly medium grained.

If moisture sensitive floor coverage are planned, we recommend the use of a polyethylene vapor membrane to reduce vapor transmission. From a slab curling standpoint, it would be preferable to place the vapor membrane below the sand cushion. However, we caution that membrane placement below the cushion could pose constructability difficulties. The use of a 6" cushion thickness rather than 4" can improve surface stability during construction. Also, it is preferred that the slab area not be exposed to rain or other means of water infiltration at the time the cushion is exposed due to water trapping in the sand above the membrane.

For floor slab design, we suggest assuming soil modulus of subgrade reaction (k values) of 75 psi/in and 200 psi/in for a clay subbase or a sand subgrade, respectively.

### **Building Backfilling**

Our recommendations for backfilling the structure appears on two standard data sheets which we have attached to this report. These sheets are entitled:

- "Freezing Weather Effects on Building Construction"
- "Basement/Retaining Wall Backfill and Water Control."
- "Floor Slab Moisture/Vapor Protection"

These sheets present information on preferred soil types, frost considerations, drainage and lateral pressures.

The footings should be backfilled to the top of the footing as soon as the concrete forms are removed to protect the underlying supporting soils from erosion and disturbance during foundation wall construction.

### **Sidewalk/Exterior Building Backfilling**

Soils placed below exterior sidewalks and driveways should be compacted to a minimum of 95% of standard Proctor density. Other recommendations relative to backfilling the structures and placing fill below exterior slabs are outlined on the standard recommendations sheet entitled "Freezing Weather Effects on Building Construction" which is provided at the end of this report. This sheet presents information on preferred soil types, frost considerations, drainage and lateral pressures.

### **Exterior Site Drainage**

As infiltration of ground water to the subgrade soils can result in increased frost heaving and subgrade weakening problems, proper site drainage is important. The pavements and sidewalks should be properly sloped and maintained to allow runoff of surface water.

Subsurface drainage is also important for long-term pavement/exterior slab performance. If granular materials more pervious than the on-site soils are used within the upper portion of the subgrade, you should consider methods of providing subsurface drainage such that water cannot buildup within the granular soils above the poorer draining soils. This can be handled by strategically placing draitile lines or french drains which can then be directed to outfall areas or storm utilities. Where sand fill is to be placed over clays near the surface, we recommend sloping or shaping the clays towards areas where they can drain.

## Pavement Recommendations

### Subgrade Preparation

We understand that the proposed pavement area will be subjected to moderate automobile traffic and light truck traffic. Further, we understand that the finished grade of the pavement will be at or slightly above existing site grade.

The surface conditions encountered at the boring locations indicate the presence of frost susceptible clays near the surface and the potential for subsurface water within 4' of existing grade. This provides the conditions necessary for frost heaving. Complete replacement of the frost susceptible soils to reduce pavement distress may be cost prohibitive for this project. The following recommendations have been provided with the understanding that periodic maintenance will be required to maintain pavement serviceability.

The following recommendations have been provided with the understanding that periodic maintenance will be required to maintain pavement serviceability.

Since bituminous pavements are "flexible" and transmit high local stress to the soil subgrade, a high level of strength is very important in the upper portion of the subgrade. However, the load intensity dissipates through the subgrade such that the high strength is usually not needed below a certain depth. In general, the needed depth of high strength soil depends on the underlying soils, but would normally be on the order of 2' to 3' for car only areas, and 3' to 4' for heavier duty areas. When the higher stability layer is thinner, shorter than "normal" pavement life, reduced serviceability and higher maintenance costs should be anticipated.

Non-organic soils should be removed if found to be unstable under a test roll. We refer you to the attached sheet entitle "Bituminous Pavement Subgrade Preparation and Design" for general information on pavement design and subgrade preparation, including items such as test roll evaluation, subgrade drainage and compaction recommendations. Fill which is placed or reworked in the pavement areas should be compacted to a minimum of 100% of standard Proctor density in the upper 3' of subgrade and to 95% below the upper 3' zone.

Ideally, it would be preferred to subcut the entire proposed paved area and place a 3' stable fill layer. As the subcut/refilling approach is somewhat costly, a more feasible approach may be to test roll the paved areas at subgrade elevation with a large rubber-tired vehicle. Subcutting could then be limited to those areas where obvious deflection or cutting occurs. With this approach, the resulting subgrade would be more variable and generally less stable. Because of this, you should realize this latter approach could result in a lower level of performance and increased maintenance requirements.

Fill placed below the upper 3' zone should be compacted in thin lifts to a minimum of 95% of standard Proctor density (ASTM:D698). To provide the needed higher strength near the surface, fill placed in the upper 3' zone should be compacted to thin lifts to a minimum of 100% of standard Proctor density. In addition to the compaction requirement, it is important that the soils placed within the upper 3' zone be moisture conditioned to a moisture content level between 65% and 102% of the optimum moisture content defined by the standard Proctor.

We highly recommend any silts be avoided as fill within the freezing zone due to their high potential for frost movements. Also, clay borrow soils are sensitive to moisture and may required moisture conditioning to attain the desired compaction level. This conditioning process can be time consuming, labor intensive and will require favorable weather. This is especially true of the upper subgrade soils requiring the 100% compaction level.

For preparation of the site, we recommend removal of the heavily organic portions of the surficial deposits present at the site about 2'. The exposed soils should be scarified and compacted to a minimum of 100% of standard Proctor density. Additional subcutting should be performed by removing any organic portions of the surficial deposits or where excessively wet subgrade conditions are encountered. An alternate to the additional subcutting would be to use a geotextile fabric in areas where specified moisture density is not achievable; also a dust free, crushed rock could be used for the initial lift to provide a stable working base. As a minimum, we recommend the correction include performing a minimum required subcut beneath the finished pavement elevation to allow placement of a continuous sand subbase layer similar to a MN/DOT Class 3. The excavations should slope slightly downward to areas where drain tiles can be placed for removal of infiltrating subsurface water. Although the top of the layer prior to subbase placement may need some minor shaping to allow subsurface drainage, changes in the subbase thicknesses should be gradual laterally.

The clay subcut and sand subbase fill system should be oversized beyond the paved portion a minimum of 1' laterally. We recommend the upper portion of fill outside of and adjacent to the surfaced areas be capped with a layer of clay which slopes downward away from the paved surfaces such that surface water is shed and not allowed to directly infiltrate to the subbase soils. We also recommend finger drains be installed near catch basins to allow any water that collects within the granular fill to be discharged into the storm sewer system.

As the sand will be placed within slow draining clays, it will be very important to drain the subgrade water buildup. We suggest a PVC drain tile line be placed laterally along the edges of the roadways and at maximum lateral spacing of 50' on center. The lines should be connected to suitable outfall or storm sewer system. To aid in preventing clogging of the perforated tile lines, we recommend that the lines be wrapped with a geotextile fabric designed for that purpose.

### Pavement Section Thickness Designs

A conservative Hyveem Stabilometer, "R" values for these frost susceptible soils would be about 10 to 12. The thicknesses of the pavement sections will depend on the type of materials present within the upper portion of the subgrade. We are available to review intermediate designs once your final plans are established. The recommended thickness designs provided below assume that paving will only take place during favorable weather conditions upon a dry, well compacted subgrade.

<u>Material</u>	<u>Section Thicknesses</u>	
	<u>Car Only Areas</u>	<u>Heavy Duty Areas</u>
Bituminous Wear	1½"	2"
Bituminous Base	1½"	2"
Class 5 Aggregate Base (Mn/DOT 3138)	6"	6"
Sand Fill (MN/DOT 3138 Class 3)	6"	12"

Again, since subsurface drainage is critical to long term performance, we recommend providing PVC tile lines spaced a minimum of 50' on-center.

The above designs could be reduced if the project owner is willing to assume the additional maintenance costs. Also, the site conditions are suited for the use of an engineering fabric and some reduction in the pavement section may be possible depending on the subgrade conditions encountered and the amount of sand subbase provided.

## **CONSTRUCTION CONSIDERATIONS**

### **Potential Difficulties**

#### **Runoff Water in Excavation**

As pointed out earlier, the on-site soils are relatively poor draining. Because of this, surface water can be expected to "perch" in the excavation during times of wetter weather. To allow observation of the excavation bottom, to reduce the potential for soil disturbance, and to facilitate filling operations, we recommend water be removed from within the excavations during construction. Based on the soils encountered, we anticipate the ground water can be controlled with conventional sump pumping. However, given the lenses and layers of wet to waterbearing sand, more intricate dewatering techniques may be required.

#### **Disturbance of Soils**

Although many of the on-site soils appear suitable, they can become disturbed under repeated construction traffic, especially if ground water is available. If soils become disturbed, they should be subcut to the underlying undisturbed soils.

#### **Cobbles and Boulders**

Glacial till soils, which are present at this site, can include cobbles and boulders. This may make excavating procedures somewhat more difficult than normal if they are encountered. Also, if cobbles or boulders are encountered at footing grade, it may be necessary to remove these oversized particles and replace them with compacted fill to allow full footing placement.

### **Excavation Sidesloping**

If unretained, the excavation should maintain sideslopes in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavation and Trenches." Even with the required OSHA sloping, ground water seepage can induce sideslope raveling or running which would require maintenance.

### **Observation and Testing**

The construction plans and specifications should be reviewed by our firm to judge the applicability of the recommendations presented in this report.

The recommendations in this report are based on the subsurface conditions found at our test boring locations. Since the soil conditions can be expected to vary away from the soil boring locations, we recommend on-site observation by a geotechnical engineer/technician during construction to review these potential changes. Soil compaction testing should be performed on new fill placed in order to judge that project specifications for compaction have been satisfied. Where fill material type is important, sieve analysis tests should be performed to judge whether the actual fill meets the recommended gradation criteria.

## **SUBSURFACE EXPLORATION**

### **General**

The subsurface exploration program included drilling seven (7) standard penetration test borings at the project site. These borings were drilled at the site on October 31, 2003. The approximate locations of the borings are shown on the attached site sketch. The surface elevations at the test boring locations were estimated based upon the benchmark elevation of 100.0' assumed at the top of the fire hydrant located on the west end of the project site.

### **Drilling Methods**

The standard penetration test borings were drilled using hollow-stem augers.

### **Boring Closure**

Bore holes were backfilled with on-site materials, bentonite pellets or grouted with neat cement. Some settlement may occur; final closure of the holes is the responsibility of the client.

## **Sampling Methods**

### **Split-Spoon Samples (SS)**

Standard penetration (split-spoon) samples were collected in general accordance with ASTM:D1586. This method consists of driving a 2" O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30". The sampler is driven a total of 18" into the soil. After an initial set of 6", the number of hammer blows to drive the sampler the final 12" is known as the standard penetration resistance or N-value.

### **Sampling Limitations**

Unless actually observed in a sample contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

### **Field Sampling/Testing Methods**

The field sampling methods for the borings are described on the included data sheet.

### **Classification Methods**

Soil classifications shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM:D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, classifications per ASTM:D2487 are possible. Otherwise, soil classifications shown on the boring logs are visual-manual judgements. We have attached charts (Appendix) illustrating the USC system, the descriptive terminology, and the symbols used on the boring logs.

### Water Level Measurements

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under "Water Level Measurements" on the logs:

- Date and Time of measurement
- Sampled Depth: lowest depth of soil sampling at the time of measurement
- Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- Cave-in Depth: depth at which measuring tape stops in the borehole
- Water Level: depth in the borehole where free water is encountered
- Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

### Sample Storage

We will retain representative samples of the soils recovered from the borings for a period of 30 days. The samples will then be discarded unless you notify us otherwise.

### Laboratory Testing

Physical laboratory tests were performed on selected soil samples to aid in judging engineering properties. The main properties considered were soil strength and compressibility. The tests performed include moisture content, pocket penetrometer, and dry density using the direct measurement method. The results of these tests appear on the boring logs, opposite samples upon which they were performed.

### LIMITATIONS

The data derived through this sampling and observation program have been used to develop our opinions about the subsurface conditions at your site. However, because no exploration program can reveal totally what is in the subsurface, conditions between borings and between samples and at other times, may differ from conditions described in this report. The exploration we conducted identified subsurface conditions only at those points where we took samples or observed ground water conditions. Depending on the sampling methods and sampling frequency, every soil layer may not be observed, and some materials or layers which are present in the ground may not be noted on the boring logs.

If conditions encountered during construction differ from those indicated by our borings, it may be necessary to alter our conclusions and recommendations, or to modify construction procedures, and the cost of construction may be affected.

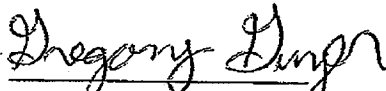
The extent and detail of information about the subsurface condition is directly related to the scope of the exploration. It should be understood, therefore, that more information may be obtained by means of additional exploration.

### STANDARD OF CARE


Our services for your project have been conducted to those standards considered normal for services of this type at this time and location. Other than this, no warranty, either expressed or implied, is intended.

### SIGNATURES

Report Prepared by:  
American Engineering Testing, Inc.

  
Gregory A. Guyer, EIT

Report Reviewed by:  
American Engineering Testing, Inc.

  
Michael R. Schmidt, PE  
Principal  
MN Reg. No. 14443

## BASEMENT/RETAINING WALL BACKFILL AND WATER CONTROL

### DRAINAGE

Below grade basements should include a perimeter backfill drainage system on the exterior side of the wall. The exception may be where basements lie within free draining sands where water will not perch in the backfill. Drainage systems should consist of perforated or slotted PVC drainage pipes located at the bottom of the backfill trench, lower than the interior floor grade. The drain pipe should be surrounded by properly graded filter rock. A filter fabric should then envelope the filter rock. The drain pipe should be connected to a suitable means of disposal, such as a sump basket or a gravity outfall. A storm sewer gravity outfall would be preferred over exterior daylighting, as the latter may freeze during winter. For non-building, exterior retaining walls, weep holes at the base of the wall can be substituted for a drain pipe.

### BACKFILLING

Prior to backfilling, damp/water proofing should be applied on perimeter basement walls. The backfill materials placed against basement walls will exert lateral loadings. To reduce this loading by allowing for drainage, we recommend using free draining sands for backfill. The zone of sand backfill should extend outward from the wall at least 2', and then upward and outward from the wall at a 30° or greater angle from vertical. As a minimum, the sands should contain no greater than 12% by weight passing the #200 sieve, which would include (SP) and (SP-SM) soils. The sand backfill should be placed in lifts and compacted with portable compaction equipment. This compaction should be to the specified levels if slabs or pavements are placed above. Where slab/pavements are not above, we recommend capping the sand backfill with a layer of clayey soil to minimize surface water infiltration. Positive surface drainage away from the building should also be maintained. If surface capping or positive surface drainage cannot be maintained, then the trench should be filled with more permeable soils, such as the Fine Filter or Coarse Filter Aggregates defined in MnDOT Specification 3149. You should recognize that if the backfill soils are not properly compacted, settlements may occur which may affect surface drainage away from the building.

Backfilling with silty or clayey soil is possible but not preferred. These soils can build-up water which increases lateral pressures and results in wet wall conditions and possible water infiltration into the basement. If you elect to place silty or clayey soils as backfill, we recommend you place a prefabricated drainage composite against the wall which is hydraulically connected to a drainage pipe at the base of the backfill trench. High plasticity clays should be avoided as backfill due to their swelling potential.

### LATERAL PRESSURES

Lateral earth pressures on below grade walls vary, depending on backfill soil classification, backfill compaction and slope of the backfill surface. Static or dynamic surcharge loads near the wall will also increase lateral wall pressure. For design, we recommend the following ultimate lateral earth pressure values (given in equivalent fluid pressure values) for a drained soil compacted to 95% of the Standard Proctor density and a level ground surface.

Soil Type	Equivalent Fluid Density	
	Active (pcf)	At-Rest (pcf)
Sands (SP or SP-SM)	35	50
Silty Sands (SM)	45	65
Fine Grained Soils (SC, CL or ML)	70	90

Basement walls are normally restrained at the top which restricts movement. In this case, the design lateral pressures should be the "at-rest" pressure situation. Retaining walls which are free to rotate or deflect should be designed using the active case. Lateral earth pressures will be significantly higher than that shown if the backfill soils are not drained and become saturated.

## FREEZING WEATHER EFFECTS ON BUILDING CONSTRUCTION

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### GENERAL

Because water expands upon freezing and soils contain water, soils which are allowed to freeze will heave and lose density. Upon thawing, these soils will not regain their original strength and density. The extent of heave and density/ strength loss depends on the soil type and moisture condition. Heave is greater in soils with higher percentages of fines (silts/clays). High silt content soils are most susceptible, due to their high capillary rise potential which can create ice lenses. Fine grained soils generally heave about 1/4" to 3/8" for each foot of frost penetration. This can translate to 1" to 2" of total frost heave. This total amount can be significantly greater if ice lensing occurs.

### DESIGN CONSIDERATIONS

Clayey and silty soils can be used as perimeter backfill, although the effect of their poor drainage and frost properties should be considered. Basement areas will have special drainage and lateral load requirements which are not discussed here. Frost heave may be critical in doorway areas. Stoops or sidewalks adjacent to doorways could be designed as structural slabs supported on frost footings with void spaces below. With this design, movements may then occur between the structural slab and the adjacent on-grade slabs. Non-frost susceptible sands (with less than 12% passing a #200 sieve) can be used below such areas. Depending on the function of surrounding areas, the sand layer may need a thickness transition away from the area where movement is critical. With sand placement over slower draining soils, subsurface drainage would be needed for the sand layer. High density extruded insulation could be used within the sand to reduce frost penetration, thereby reducing the sand thickness needed. We caution that insulation placed near the surface can increase the potential for ice glazing of the surface.

The possible effects of adfreezing should be considered if clayey or silty soils are used as backfill. Adfreezing occurs when backfill adheres to rough surfaced foundation walls and lifts the wall as it freezes and heaves. This occurrence is most common with masonry block walls, unheated or poorly heated building situations and clay backfill. The potential is also increased where backfill soils are poorly compacted and become saturated. The risk of adfreezing can be decreased by placing a low friction separating layer between the wall and backfill.

Adfreezing can occur on exterior piers (such as deck, fence or other similar pier footings), even if a smooth surface is provided. This is more likely in poor drainage situations where soils become saturated. Additional footing embedment and/or widened footings below the frost zones (which includes tensile reinforcement) can be used to resist uplift forces. Specific designs would require individual analysis.

### CONSTRUCTION CONSIDERATIONS

Foundations, slabs and other improvements which may be affected by frost movements should be insulated from frost penetration during freezing weather. If filling takes place during freezing weather, all frozen soils, snow and ice should be stripped from areas to be filled prior to new fill placement. The new fill should not be allowed to freeze during transit, placement or compaction. This should be considered in the project scheduling, budgeting and quantity estimating. It is usually beneficial to perform cold weather earthwork operations in small areas where grade can be attained quickly rather than working larger areas where a greater amount of frost stripping may be needed. If slab subgrade areas freeze, we recommend the subgrade be thawed prior to floor slab placement. The frost action may also require reworking and recompaction of the thawed subgrade.

## BITUMINOUS PAVEMENT SUBGRADE PREPARATION AND DESIGN

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### GENERAL

Bituminous pavements are considered layered "flexible" systems. Dynamic wheel loads transmit high local stresses through the bituminous/base onto the subgrade. Because of this, the upper portion of the subgrade requires high strength/stability to reduce deflection and fatigue of the bituminous/base system. The wheel load intensity dissipates through the subgrade such that the high level of soil stability is usually not needed below about 2' to 4' (depending on the anticipated traffic and underlying soil conditions). This is the primary reason for specifying a higher level of compaction within the upper subgrade zone versus the lower portion. Moderate compaction is usually desired below the upper critical zone, primarily to avoid settlements/sags of the roadway. However, if the soils present below the upper 3' subgrade zone are unstable, attempts to properly compact the upper 3' zone to the 100% level may be difficult or not possible. Therefore, control of moisture just below the 3' level may be needed to provide a non-yielding base upon which to compact the upper subgrade soils.

Long-term pavement performance is dependent on the soil subgrade drainage and frost characteristics. Poor to moderate draining soils tend to be susceptible to frost heave and subsequent weakening upon thaw. This condition can result in irregular frost movements and "popouts," as well as an accelerated softening of the subgrade. Frost problems become more pronounced when the subgrade is layered with soils of varying permeability. In this situation, the free-draining soils provide a pathway and reservoir for water infiltration which exaggerates the movements. The placement of a well drained sand subbase layer as the top of subgrade can minimize trapped water, smooth frost movements and significantly reduce subgrade softening. In wet, layered and/or poor drainage situations, the long-term performance gain should be significant. If a sand subbase is placed, we recommend it be a "Select Granular Borrow" which meets Mn/DOT Specification 3149.2B2.

### PREPARATION

Subgrade preparation should include stripping surficial vegetation and organic soils. Where the exposed soils are within the upper "critical" subgrade zone (generally 2½' deep for "auto only" areas and 3' deep for "heavy duty" areas), they should be evaluated for stability. Excavation equipment may make such areas obvious due to deflection and rutting patterns. Final evaluation of soils within the critical subgrade zone should be done by test rolling with heavy rubber-tired construction equipment, such as a loaded dump truck. Soils which rut or deflect 1" or more under the test roll should be corrected by either subcutting and replacement; or by scarification, drying, and recompaction. Reworked soils and new fill should be compacted per the "Specified Density Method" outlined in Mn/DOT Specification 2105.3F1 (a minimum of 100% of Standard Proctor density in the upper 3' subgrade zone, and a minimum of 95% below this).

Subgrade preparation scheduling can be an important consideration. Fall and Spring seasons usually have unfavorable weather for soil drying. Stabilizing non-sand subgrades during these seasons may be difficult, and attempts often result in compromising the pavement quality. Where construction scheduling requires subgrade preparation during these times, the use of a sand subbase becomes even more beneficial for constructability reasons.

### SUBGRADE DRAINAGE

If a sand subbase layer is used, it should be provided with a means of subsurface drainage to prevent water build-up. This can be in the form of draitile lines which dispose into storm sewer systems, or outlets into ditches. Where sand subbase layers include sufficient sloping, and water can migrate to lower areas, draitile lines can be limited to finger drains at the catch basins. Even if a sand layer is not placed, strategically placed draitile lines can aid in improving pavement performance. This would be most important in areas where adjacent non-paved areas slope towards the pavement. Perimeter edge drains can aid in intercepting water which may infiltrate below the pavement.

## FLOOR SLAB MOISTURE/VAPOR PROTECTION

Floorslab design relative to moisture/vapor protection should consider the type and location of two elements, a granular layer and a vapor membrane (vapor retarder, water resistant barrier or vapor barrier). In the following sections, the pros and cons of the possible options regarding these elements will be presented, such that you and your specifier can make an engineering decision based on the benefits and costs of the choices.

### GRANULAR LAYER

In American Concrete Institute (ACI) 302.1-96, a "base material" is recommended, rather than the conventional cleaner "sand cushion" material. The manual maintains that clean sand (common "cushion" sand) is difficult to compact and maintain until concrete placement is complete. ACI recommends a clean, fine graded material (with at least 10% to 30% of particles passing a #100 sieve) which is not contaminated with clay, silt or organic material. We refer you to ACI 302.1-96 for additional details regarding the requirements for the base material.

In cases where potential static water levels or significant perched water sources appear near or above the floor slab, an underfloor drainage system may be needed wherein a drain tile system is placed within a thicker clean sand or gravel layer. Such a system should be properly engineered depending on subgrade soil types and rate/head of water inflow.

### VAPOR MEMBRANE

The need for a vapor membrane depends on whether the floor slab will have a vapor sensitive covering, will have vapor sensitive items stored on the slab, or if the space above the slab will be a humidity controlled area. If the project does not have this vapor sensitivity or moisture control need, placement of a vapor membrane may not be necessary. Your decision will then relate to whether to use the ACI base material or a conventional sand cushion layer. However, if any of the above sensitivity issues apply, placement of a vapor membrane is recommended. Some floor covering systems (adhesives and flooring materials) require a vapor membrane to maintain a specified maximum slab moisture content as a condition of their warranty.

### VAPOR MEMBRANE/GRANULAR LAYER PLACEMENT

A number of issues should be considered when deciding whether to place the vapor membrane above or below the granular layer. The benefits of placing the slab on a granular layer, with the vapor membrane placed below the granular layer, include reduction of the following:

- Slab curling during the curing and drying process.
- Time of bleeding, which allows for quicker finishing.
- Vapor membrane puncturing.
- Surface blistering or delamination caused by an extended bleeding period.
- Cracking caused by plastic or drying shrinkage.

The benefits of placing the vapor membrane over the granular layer include the following:

- The moisture emission rate is achieved faster.
- Eliminates a potential water reservoir within the granular layer above the membrane.
- Provides a "slip surface", thereby reducing slab restraint and the associated random cracking.

If a membrane is to be used in conjunction with a granular layer, the approach recommended depends on slab usage and the construction schedule. The vapor membrane should be placed above the granular layer when:

- Vapor sensitive floor covering systems are used or vapor sensitive items will be directly placed on the slab.
- The area will be humidity controlled, but the slab will be placed before the building is enclosed and sealed from rain.
- Required by a floor covering manufacturer's system warranty.

The vapor membrane should be placed below the granular layer when:

- Used in humidity controlled areas (without vapor sensitive coverings/stored items), with the roof membrane in place, and the building enclosed to the point where precipitation will not intrude into the slab area. Consideration should be given to slight sloping of the membrane to edges where drain tile or other disposal methods can alleviate potential water sources, such as pipe or roof leaks, foundation wall damp proofing failure, fire sprinkler system activation, etc.

There may be cases where membrane placement may have a detrimental effect on the subgrade support system (e.g., expansive soils). In these cases, your decision will need to weigh the cost of subgrade options and the performance risks.

## EXCAVATION AND REFILLING FOR STRUCTURAL SUPPORT

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### EXCAVATION

Excavations for structural support at soil boring locations should be taken to depths recommended in the geotechnical report. Since conditions can vary, recommended excavation depths between and beyond the boring locations should be evaluated by geotechnical field personnel. If ground water is present, the excavation should be dewatered to avoid the risk of unobservable poor soils being left in-place. Excavation base soils may become disturbed due to construction traffic, ground water or other reasons. Such soils should be subcut to underlying undisturbed soils. Where the excavation base slopes steeper than 4:1, the excavation bottom should be benched across the slope parallel to the excavation contour.

Soil stresses under footings spread out with depth. Therefore, the excavation bottom and subsequent fill system should be laterally oversized beyond footing edges to support the footing stresses. A lateral oversize equal to the depth of fill below the footing (i.e., 1:1 oversize) is usually recommended. The lateral oversize is usually increased to 1.5:1 where compressible organic soils are exposed on the excavation sides. Variations in oversize requirements may be recommended in the geotechnical report or can be evaluated by the geotechnical field personnel.

Unless the excavation is retained, the backslopes should be maintained in accordance with OSHA Regulations (Standards - 29 CFR), Part 1926, Subpart P, "Excavations" (found on [www.osha.gov](http://www.osha.gov)). Even with the required OSHA sloping, ground water can induce sideslope raveling or running which could require that flatter slopes or other approaches be used.

### FILLING

Filling should proceed only after the excavation bottom has been approved by the geotechnical engineer/technician. Approved fill material should be uniformly compacted in thin lifts to the compaction levels specified in the geotechnical report. The lift thickness should be thin enough to achieve specified compaction through the full lift thickness with the compaction equipment utilized. Typical thicknesses are 6" to 9" for clays and 12" to 18" for sands. Fine grained soils are moisture sensitive and are often wet (water content exceeds the "optimum moisture content" defined by a Proctor test). In this case, the soils should be scarified and dried to achieve a water content suitable for compaction. This drying process can be time consuming, labor intensive, and requires favorable weather.

Select fill material may be needed where the excavation bottom is sensitive to disturbance or where standing water is present. Sands (SP) which are medium to coarse grained are preferred, and can be compacted in thicker lift thicknesses than finer grained soils.

Filling operations for structural support should be closely monitored for fill type and compaction by a geotechnical technician. Monitoring should be on a full-time basis in cases where vertical fill placement is rapid; during freezing weather conditions; where ground water is present; or where sensitive bottom conditions are present.

### EXCAVATION/REFILLING DURING FREEZING TEMPERATURES

Soils that freeze will heave and lose density. Upon thawing, these soils will not regain their original strength and density. The extent of heave and density loss depends on the soil type and moisture condition; and is most pronounced in clays and silts. Foundations, slabs, and other improvements should be protected from frost intrusion during freezing weather. For earthwork during freezing weather, the areas to be filled should be stripped of frozen soil, snow and ice prior to new fill placement. In addition, new fill should not be allowed to freeze during or after placement. For this reason, it may be preferable to do earthwork operations in small plan areas so grade can be quickly attained instead of large areas where much frost stripping may be needed.

## EXPLORATION/CLASSIFICATION METHODS

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### SAMPLING METHODS

#### **Split-Spoon Samples (SS)**

Standard penetration (split-spoon) samples were collected in general accordance with ASTM:D1586. This method consists of driving a 2" O.D. split barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30". The sampler is driven a total of 18" into the soil. After an initial set of 6", the number of hammer blows to drive the sampler the final 12" is known as the standard penetration resistance or N-value.

#### **Disturbed Samples (DS)**

Sample types described as "DS" on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

#### **Sampling Limitations**

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

### CLASSIFICATION METHODS

Soil classifications shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM:D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM:D2487 are possible. Otherwise, soil classifications shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

### WATER LEVEL MEASUREMENTS

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under "Water Level Measurements" on the logs:

- Date and Time of measurement
- Sampled Depth: lowest depth of soil sampling at the time of measurement
- Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- Cave-in Depth: depth at which measuring tape stops in the borehole
- Water Level: depth in the borehole where free water is encountered
- Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

### SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.

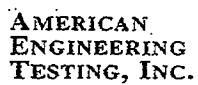
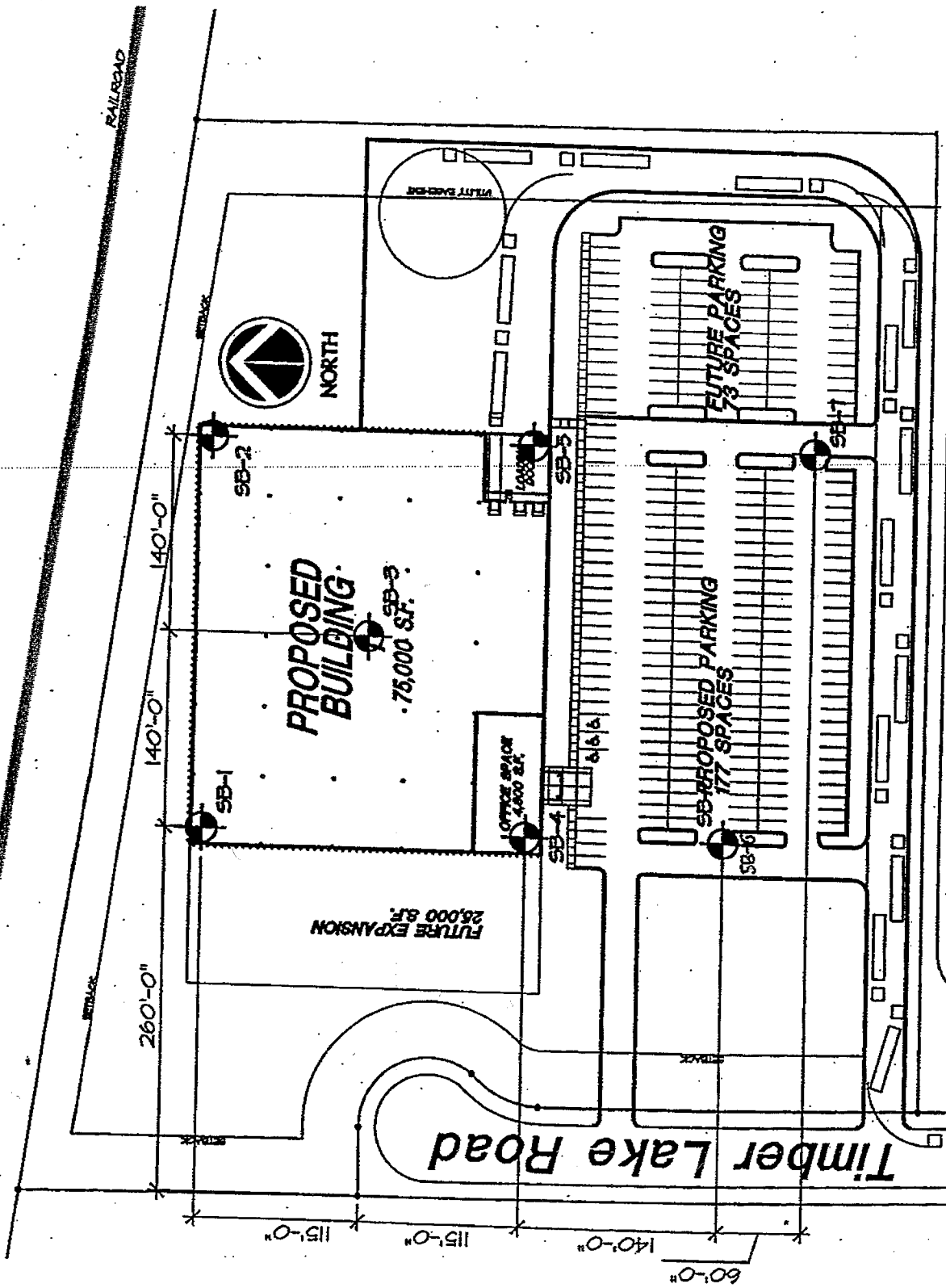

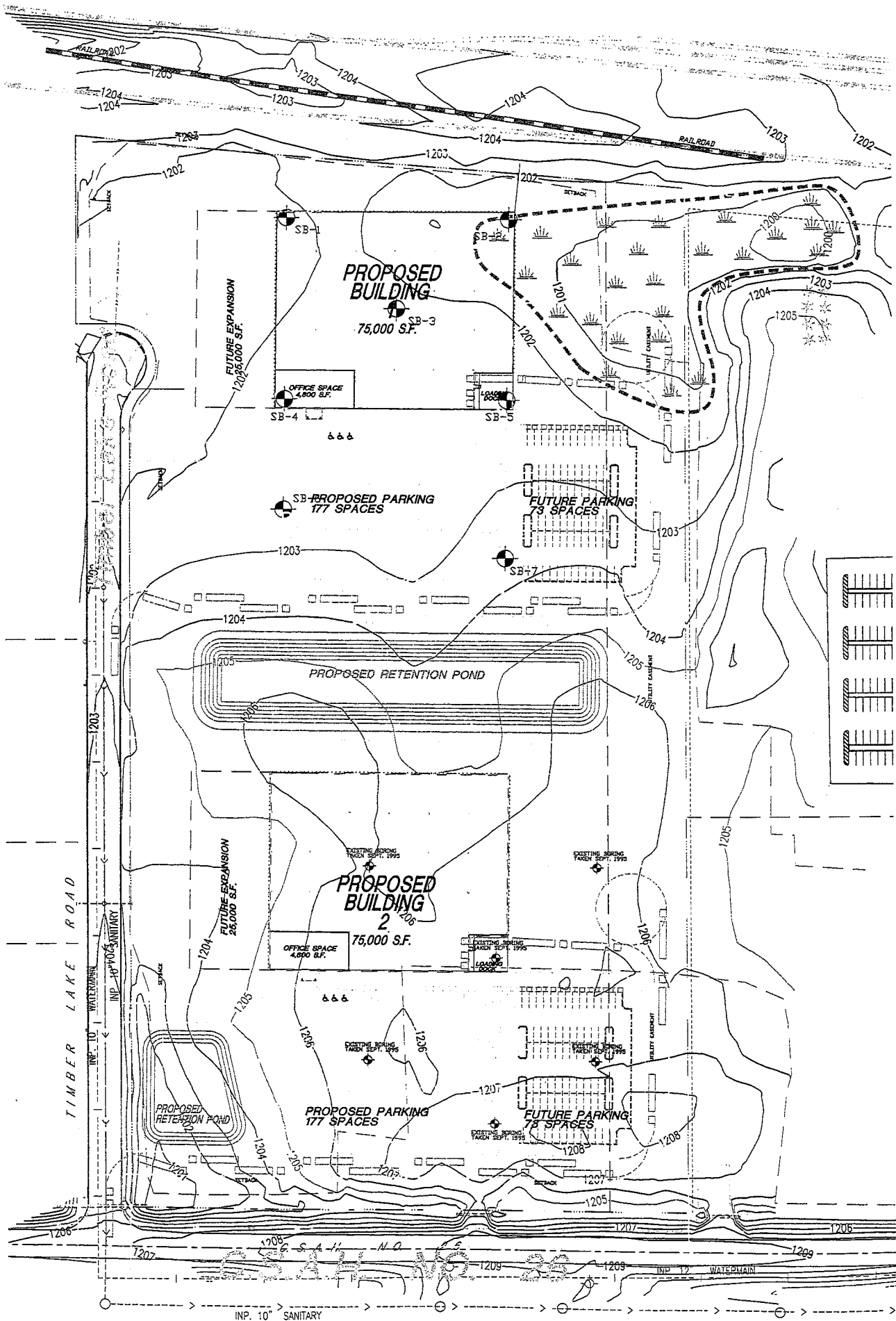


Figure: 1



 <b>AMERICAN ENGINEERING TESTING, INC.</b>	<b>Project</b> Virtual Building Fairmont, MN	<b>Subject:</b> Boring Locations	<b>AET Job No:</b> 08-05070	<b>Date:</b> Nov. 30, 2003
<b>Scale:</b> NTS	<b>Drawn By:</b> GG	<b>Checked By:</b> MS	<b>Figure 2</b>	





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## SUBSURFACE BORING LOG

AET JOB NO: **08-05070**

LOG OF BORING NO. **B-1 (p. 1 of 1)**

PROJECT: **Virtual Building; Fairmont, Minnesota**

DEPTH IN FEET	SURFACE ELEVATION: <u>98.3'</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC. IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	qp
1	Sandy Lean Clay w/visible organics, black	Topsoil		M	DS						
2	Sandy Lean Clay w/a little gravel, brown and grey mottled, medium to stiff (CL)	Till									
3			6	M	SS	3					
4											
5			8	M	SS	6	19	91			1 1/2
6											
7											
8			11	M	SS	8					
9											
10	Sandy Lean Clay w/a little gravel, grey, stiff (CL)		11	M	SS	12					
11											
12											
13			10	M	SS	6					
14											
15			11	M	SS	14					
16											
17											
18											
19											
20			9	M	SS	10					
21	END OF BORING										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG	
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID-LEVEL		WATER LEVEL
0-19.5'	3.25" HSA	10/31/03	9:30	21'	19.5'	19.5'	None		None
BORING COMPLETED: 10/31/03									
CC: CF CA: BL Rig: 24R									



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## SUBSURFACE BORING LOG

AET JOB NO: **08-05070**

LOG OF BORING NO. **B-2 (p. 1 of 1)**

PROJECT: **Virtual Building; Fairmont, Minnesota**

DEPTH IN FEET	SURFACE ELEVATION: <u>98.4'</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC. IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	QP
1	Sandy Lean Clay w/visible organics, black	Topsoil		M	DS						
2	Sandy Lean Clay w/a little gravel, brown and grey mottled, medium to stiff (CL)	Till									
3			6	M	SS	3	17				1 1/2
4											
5			10	M	SS	5					
6											
7											
8			9	M	SS	8					
9											
10											
11											
12	Sandy Lean Clay w/a little gravel, grey, stiff (CL)										
13			11	M	SS	10					
14											
15			13	M	SS	10					
16											
17											
18											
19											
20			12	M	SS	10					
21	END OF BORING										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-19.5'	3.25" HSA	10/31/03	10:30	21'	19.5'	19.5'	None	None	
BORING COMPLETED: 10/31/03									
CC: CF CA: BL Rig: 24R									



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# SUBSURFACE BORING LOG

AET JOB NO: **08-05070**

LOG OF BORING NO. **B-3 (p. 1 of 1)**

PROJECT: **Virtual Building; Fairmont, Minnesota**

DEPTH IN FEET	SURFACE ELEVATION: <u>98.9'</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC. IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	qp
1	Sandy Lean Clay w/visible organics, black	Topsoil		M	DS						
2	Sandy Lean Clay w/a little gravel, brown and grey mottled, stiff to very stiff (CL)	Till									
3			6	M	SS	3					
4											
5			10	M	SS	6	14	107			2.0
6											
7											
8			11	M	SS	8					
9											
10			17	M	SS	10					
11											
12	Sandy Lean Clay w/a little gravel, grey, stiff (CL)										
13			10	M	SS	10					
14											
15			11	M	SS	10					
16											
17											
18											
19											
20			11	M	SS	12					
21	END OF BORING										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY OF THIS LOG
0-19.5'	3.25"HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/31/03	11:30	21'	19.5'	19.5'	None	None	
BORING COMPLETED: 10/31/03									
CC: CF CA: BL Rig: 24R									



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TESTING, INC.

# SUBSURFACE BORING LOG

AET JOB NO: **08-05070**

LOG OF BORING NO. **B-4 (p. 1 of 1)**

PROJECT: **Virtual Building; Fairmont, Minnesota**

DEPTH IN FEET	SURFACE ELEVATION: <b>98.3'</b> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC. IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	qp
1	Sandy Lean Clay w/visible organics, black	Topsoil		M	DS						
2	Sandy Lean Clay w/a little gravel, brown and grey mottled, medium to very stiff (CL)	Fill	6	M	SS	2	16				1 3/4
3											
4											
5											
6											
7											
8											
9											
10											
11											
12	Sandy Lean Clay w/a little gravel, grey, stiff (CL)		10	M	SS	10					
13											
14											
15											
16											
17											
18											
19											
20			12	M	SS	12					
21											
21	END OF BORING										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-19.5'	3.25" HSA	10/31/03	12:30	21'	19.5'	19.5'	None	None	
BORING COMPLETED: 10/31/03									
CC: CF CA: BL Rig: 24R									



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# SUBSURFACE BORING LOG

AET JOB NO: **08-05070**

LOG OF BORING NO. **B-5 (p. 1 of 1)**

PROJECT: **Virtual Building; Fairmont, Minnesota**

DEPTH IN FEET	SURFACE ELEVATION: <u>99.2'</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC. IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	qp
1	Sandy Lean Clay w/visible organics, black	Topsoil		M	DS						
2	Sandy Lean Clay w/a little gravel, brown and grey mottled, medium to stiff (CL)	Till									
3			6	M	SS	3					
4											
5			10	M	SS	8					
6											
7											
8			11	M	SS	10					
9											
10			15	M	SS	12					
11											
12	Sandy Lean Clay w/a little gravel, grey, stiff (CL)										
13			11	M	SS	10					
14											
15			12	M	SS	10					
16											
17											
18											
19											
20			11	M	SS	12					
21	END OF BORING										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-19.5'	3.25"HSA	10/31/03	1:30	21'	19.5'	19.5'	None	None	
BORING COMPLETED: 10/31/03									
CC: CF CA: BL Rig: 24R									



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## SUBSURFACE BORING LOG

AET JOB NO: **08-05070**

LOG OF BORING NO. **B-6 (p. 1 of 1)**

PROJECT: **Virtual Building; Fairmont, Minnesota**

DEPTH IN FEET	SURFACE ELEVATION: <b>98.6'</b> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC. IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	qp
1	Sandy Lean Clay w/visible organics, black	Topsoil		M	DS						
2	Sandy Lean Clay w/a little gravel, brown and grey mottled, medium to very stiff (CL)	Till									
3			6	M	SS	2					
4											
5			9	M	SS	10					
6											
7											
8			11	M	SS	10					
9											
10			17	M	SS	10					
11	END OF BORING										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-9.5'	3.25"HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/31/03	2:15	11'	9.5'	9.5'	None	None	
BORING COMPLETED: 10/31/03									
CC: CF CA: BL Rig: 24R									



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## SUBSURFACE BORING LOG

AET JOB NO: **08-05070**

LOG OF BORING NO. **B-7 (p. 1 of 1)**

PROJECT: **Virtual Building; Fairmont, Minnesota**

DEPTH IN FEET	SURFACE ELEVATION: <b>99.8'</b> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC. IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	qp
1	Sandy Lean Clay w/visible organics, black	Topsoil		M	DS						
2	Sandy Lean Clay w/a little gravel, brown and grey mottled, medium to very stiff (CL)	Till									
3			6	M	SS	3					
4											
5			10	M	SS	8					
6											
7											
8			11	M	SS	10					
9											
10			15	M	SS	12					
11	END OF BORING										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-9.5'	3.25" HSA	10/31/03	3:00	11'	9.5'	9.5'	None	None	
BORING COMPLETED: 10/31/03									
CC: CF CA: BL Rig: 24R									

**GENERAL TERMINOLOGY NOTES FOR  
SOIL IDENTIFICATION AND DESCRIPTION**

<u>GRAIN SIZE</u>		<u>GRAVEL PERCENTAGES</u>	
<u>Term</u>	<u>Particle Size</u>	<u>Term</u>	<u>Percent</u>
Boulders	Over 12"	A Little Gravel	3%-15%
Cobbles	3" to 12"	With Gravel	15%-30%
Gravel	#4 sieve to 3"	Gravelly	30%-50%
Sand	#200 to #4 sieve		
Fines (silt & clay)	Pass #200 sieve		
<u>CONSISTENCY OF PLASTIC SOILS</u>		<u>RELATIVE DENSITY OF NON-PLASTIC SOILS</u>	
<u>Term</u>	<u>N-Value, BPF</u>	<u>Term</u>	<u>N-Value, BPF</u>
Very Soft	less than 2	Very Loose	0-4
Soft	2-4	Loose	5-10
Firm (Medium)	5-8	Medium Dense	11-30
Stiff	9-15	Dense	31-50
Very Stiff	16-30	Very Dense	Greater than 50
Hard	Greater than 30		
<u>MOISTURE/FROST CONDITION</u> (MC Column)		<u>LAYERING NOTES</u>	
D (Dry):	Absence of moisture, dusty, dry to touch.	Laminations:	Layers less than ½" thick of differing material or color.
M (Moist):	Damp, although free water not visible. Soil may still have a high water content (over "optimum").	Lenses:	Pockets or layers greater than ½" thick of differing material or color.
W (Wet/ Waterbearing):	Free water visible. Intended to describe non-plastic soils. Waterbearing usually relates to sands and sands with silt.		
F (Frozen):	Soil frozen.		
<u>FIBER CONTENT OF PEAT</u>		<u>ORGANIC/ROOTS DESCRIPTION</u>	
<u>Term</u>	<u>Fiber Content (Visual Estimate)</u>	Soils are described as organic, if soil is not peat and is judged to have sufficient organic fines content to influence the soil properties.	
Fibric:	Greater than 67%	With roots:	Judged to have sufficient quantity of roots to influence the soil properties.
Hemic:	33-67%	Trace roots:	Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.
Sapric:	Less than 33%		

# CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D 2487

TABLE 1 Soil Classification Chart

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests <sup>a</sup>				Soil Classification	
				Group Symbol	Group Name <sup>b</sup>
Coarse-Grained Soils More than 50 % retained on No. 200 sieve	Gravels More than 50 % of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5 % fines <sup>c</sup>	$C_u \geq 4$ and $1 \leq C_c \leq 3^e$	GW	Well-graded gravel <sup>f</sup>
			$C_u < 4$ and/or $1 > C_c > 3^e$	GP	Poorly graded gravel <sup>f</sup>
		Gravels with Fines More than 12 % fines <sup>c</sup>	Fines classify as ML or MH	GM	Silty gravel <sup>GMN</sup>
			Fines classify as CL or CH	GC	Clayey gravel <sup>GCN</sup>
	Sands 50 % or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5 % fines <sup>d</sup>	$C_u \geq 6$ and $1 \leq C_c \leq 3^e$	SW	Well-graded sand <sup>f</sup>
			$C_u < 6$ and/or $1 > C_c > 3^e$	SP	Poorly graded sand <sup>f</sup>
		Sands with Fines More than 12 % fines <sup>d</sup>	Fines classify as ML or MH	SM	Silty sand <sup>SMN</sup>
			Fines classify as CL or CH	SC	Clayey sand <sup>SCN</sup>
Fine-Grained Soils 50 % or more passes the No. 200 sieve	Silt and Clays Liquid limit less than 50	inorganic	$PI > 7$ and plots on or above "A" line <sup>g</sup>	CL	Lean clay <sup>CLN</sup>
			$PI < 4$ or plots below "A" line <sup>g</sup>	ML	Silt <sup>MLN</sup>
		organic	Liquid limit - oven dried Liquid limit - not dried $< 0.75$	OL	Organic clay <sup>OLN</sup> Organic silt <sup>OLN</sup>
			$PI$ plots on or above "A" line	CH	Fat clay <sup>CHN</sup>
	Silt and Clays Liquid limit 50 or more	inorganic	$PI$ plots below "A" line	MH	Elastic silt <sup>MHN</sup>
			Liquid limit - oven dried Liquid limit - not dried $< 0.75$	OH	Organic clay <sup>OLN</sup> Organic silt <sup>OLN</sup>
		organic		PT	Peat

Highly organic soils

Primarily organic matter, dark in color, and organic odor

<sup>a</sup> Based on the material passing the 3-in. (75-mm) sieve.  
<sup>b</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

<sup>c</sup> Gravels with 5 to 12 % fines require dual symbols:  
GW-GM well-graded gravel with silt  
GW-GC well-graded gravel with clay  
GP-GM poorly graded gravel with silt  
GP-GC poorly graded gravel with clay

<sup>d</sup> Sands with 5 to 12 % fines require dual symbols:  
SW-SM well-graded sand with silt  
SW-SC well-graded sand with clay  
SP-SM poorly graded sand with silt  
SP-SC poorly graded sand with clay

$$C_u = D_{60}/D_{10} \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

<sup>e</sup> If soil contains  $\geq 15$  % sand, add "with sand" to group name.

<sup>f</sup> If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

<sup>g</sup> If fines are organic, add "with organic fines" to group name.

<sup>h</sup> If soil contains  $\geq 15$  % gravel, add "with gravel" to group name.

<sup>i</sup> If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

<sup>j</sup> If soil contains 15 to 29 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.

<sup>k</sup> If soil contains  $\geq 30$  % plus No. 200, predominantly sand, add "sandy" to group name.

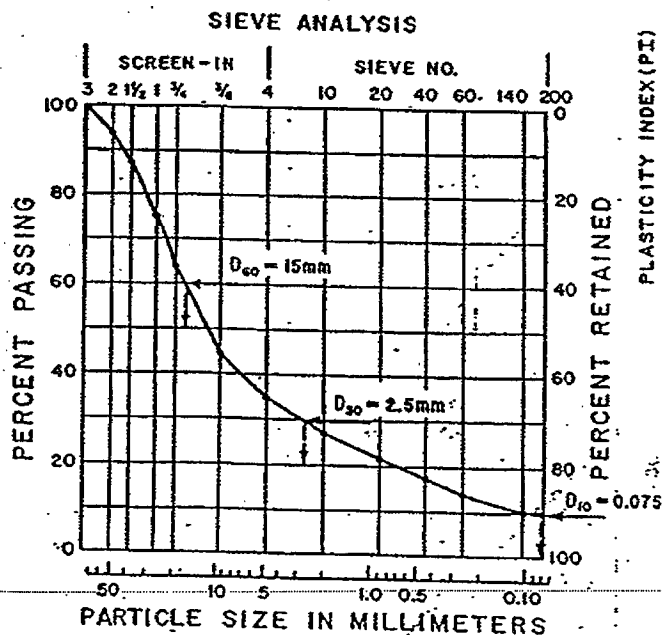
<sup>l</sup> If soil contains  $\geq 30$  % plus No. 200, predominantly gravel, add "gravelly" to group name.

<sup>m</sup>  $PI \geq 4$  and plots on or above "A" line.

<sup>n</sup>  $PI < 4$  or plots below "A" line.

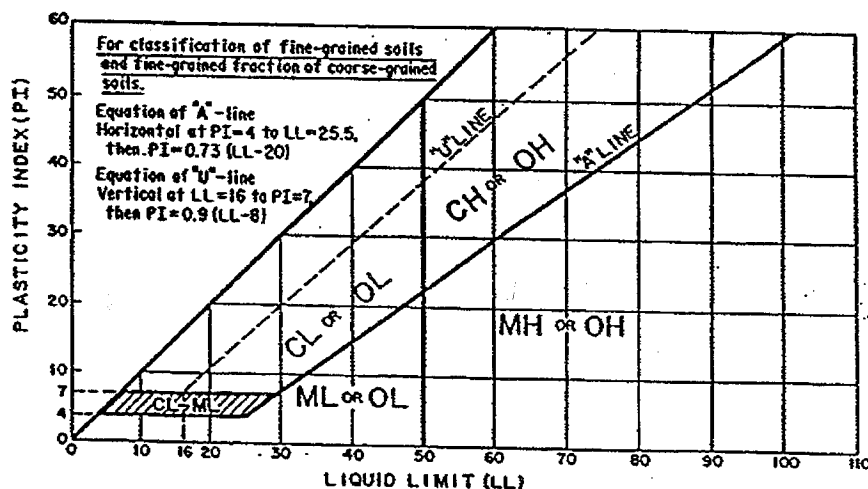
<sup>o</sup>  $PI$  plots on or above "A" line.

<sup>p</sup>  $PI$  plots below "A" line.



$$C_u = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200 \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$$

Mkto (Geo-39) (1/94)



## BORING LOG NOTES

### DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
B,H,N:	Size of flush-joint casing
CA:	Crew Assistant (initials)
CAS:	Pipe casing, number indicates nominal diameter in inches
CC:	Crew Chief (initials)
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RD:	Rotary drilling with fluid and roller or drag bit
REC:	In split-spoon (see notes) and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
REV:	Revert drilling fluid
SS:	Standard split-spoon sampler (steel; 1 3/8" is inside diameter; 2" outside diameter); unless indicated otherwise
SU:	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and 140-pound hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
<u>W</u> :	Water level directly measured in boring
<u>W</u> :	Estimated water level based solely on sample appearance

### TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density, pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:	Plastic Limit, %
q <sub>p</sub> :	Pocket Penetrometer strength, tsf (approximate)
q <sub>c</sub> :	Static cone bearing pressure, tsf
q <sub>u</sub> :	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designator in percent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remoulded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

### STANDARD PENETRATION TEST NOTES

The standard penetration test consists of driving the sampler with a 140-pound hammer and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM:D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1 below the slash.

The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM:D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18").